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A new species of *Cleruchus* (Hymenoptera, Mymaridae), an egg parasitoid of the invasive *Cis chinensis* (Coleoptera, Ciidae) in Switzerland, with new records of other congeners in Europe

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Abstract

A fairyfly (Hymenoptera, Mymaridae) *Cleruchus breviclava* Triapitsyn & Coray, **sp. nov.** is described and illustrated. The new species is an egg parasitoid of the invasive *Cis chinensis* Lawrence (Coleoptera, Ciidae) in *Antrodia xantha* fungus (Polyporales, Fomitopsidaceae) in Basel, Switzerland; it is also known from low mountains in Germany and Switzerland. Supporting data on the "barcoding" region of the mitochondrial cytochrome c oxidase subunit I gene, as well as separate regions of nuclear ribosomal RNA, the D2 region of 28S and the internal transcribed spacer 2, provide strong evidence of conspecificity of the morphologically variable macropterous and strongly brachypterous individuals of *C. breviclava*. Macropterous females of the new species are most similar to those of *C. detritus* Bakkendorf, also known from Switzerland. New records are provided for some other species of *Cleruchus* Enock in Europe. A key to both sexes of the described European species of the genus is given.

Key Words

Integrative taxonomy, molecular analysis, Chalcidoidea, distribution, Palaearctic, brachyptery

Introduction

Members of the cosmopolitan fairyfly genus *Cleruchus* Enock (Hymenoptera, Mymaridae) are not very commonly collected in Europe although they are definitely not rare there, particularly in some habitats such as mixed and deciduous forests. Most likely, as egg parasitoids of Coleoptera in leaf litter and soil or in certain concealed microhabitats, e.g. of various Ciidae in bracket fungi (Polyporales) and of some leaf-rolling Rhynchitinae (Attelabidae) (Bakkendorf 1964; Novicky 1965; Viggiani 1970; Triapitsyn and Moraal 2008; Triapitsyn et al. 2011; Triapitsyn 2014), they do not very often get into sweep and Malaise trap samples. However, they are more frequently found in yellow pan, flight interception and pitfall trap samples, as well as in Winkler and Berlese funnel extractors (Triapitsyn 2014). One species, *C. janetscheki* Novicky, was collected at moderately to high altitudes in Alpine habitats in Austria (Novicky 1965) and Italy (Viggiani 1970).

The Palearctic species of *Cleruchus* were reviewed and keyed (both sexes) by Triapitsyn (2014). However, they still remain rather poorly known as their minute size and common brachyptery or aptery in some species make their identification quite difficult in the absence of genetic libraries, morphometric data on intraspecific variability, and good quality preparations of historic specimens.

The most recent generic diagnosis of *Cleruchus*, given by Triapitsyn (2014), is accepted here; according to it *Cleruchus* is more narrowly defined as having an entire clava of the female antenna; all the Palaearctic species of the genus have this feature. In Europe, both sexes of *Cleruchus* can be recognized using the generic key in Samková et al. (2020). Unlike some other Mymaridae, males of the genus can be quite diagnostic.

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Here we describe an interesting new species of *Cleruchus* which was reared from the invasive minute tree-fungus beetle *Cis chinensis* Lawrence (Ciidae) in *Antrodia xantha* fungus (Polyporales, Fomitopsidaceae) in Basel, Switzerland (Coray et al. 2022), which has both macropterous and strongly brachypterous individuals of both sexes that are quite variable morphologically. Their conspecificity is demonstrated by the genetic data presented. We also provide new records of some other species of *Cleruchus* in Europe and a key to both sexes of its described European species.

Materials and methods

Specimen collection

On three days (June 27/28 and July 11 2021), samples of the fungus *Antrodia xantha* infested with *Cis chinensis* were collected on a block of *Pinus strobus* in the therapy garden of the campus of the University Psychiatric Clinics in Basel (Switzerland) (47°34'16.75"N, 7°33'50.15"E, 266 m). Almost exclusively in the June 27 sample, a large series of an unknown Mymaridae was noted between July 8 and 26. Live specimens of these emerged wasps were preserved by A. Coray in 90% and 75% ethanol, identified as a possible new *Cleruchus* sp., and shipped to the first author for mounting and further determination. These specimens were used for both molecular analyses and taxonomic studies (as type material of the new species described below).

Additional material of *Cleruchus* spp. from some other European countries was sent to the first author for identification from the insect collection of Mitox Consultants, Amsterdam, Netherlands.

Taxonomic studies

Morphological terms used in the taxonomic description of the new species and the key follow Gibson (1997) and Triapitsyn (2014). Most measurements (as length or length: width for the wings) are given in micrometres (µm) unless specified otherwise for body length (in mm) other than in the description. Abbreviations used in the description and key are:

F funicle segment of the female antenna or flagellomere of the male antenna;

mps multiporous plate sensillum or sensilla on the antennal flagellar segments (= longitudinal sensillum or sensilla, or sensory ridge(s)).

Due to their minute size, specimens were dissected and slide-mounted in Canada balsam directly from ethanol. Slide mounts were examined under a Zeiss Axioskop 2 plus compound microscope (Carl Zeiss Microscopy, LLC, Thornwood, New York, USA) and photographed using the Auto-Montage system (Syncroscopy, Princeton, New Jersey, USA). Photographs were retouched where necessary using Adobe Photoshop (Adobe Systems, Inc., San Jose, California, USA).

Specimens examined are deposited in the collections with the following acronyms:

MCAN Insect collection of Mitox Consultants, Amsterdam, Netherlands;

NHMB Naturhistorisches Museum Basel, Basel, Basel-Stadt, Switzerland;

UCRC Entomology Research Museum, Department of Entomology, University of California, Riverside, California, USA.

DNA extraction, amplification, and sequencing

DNA was extracted from four individual wasps, one macropterous female (PR21-581, UCRC_ENT 00541371), one strongly brachypterous female (PR21-583, UCRC_ENT 005413713), one macropterous male (PR21-582, UCRC_ENT 00541372), and one strongly brachypterous male (PR21-584, UCRC_ENT 00541374) using the "HotSHOT" method of Truett et al. (2000), in a total volume of 80 µL. This non-destructive method allowed for the recovery and slide-mounting of each specimen following extraction; each slide was then labeled with the assigned P. F. Rugman-Jones' primary molecular voucher PR number and UCRC database UCRC_ENT number.

The polymerase chain reaction (PCR) was employed to amplify the "barcoding" region of the mitochondrial cytochrome c oxidase subunit I gene (COI) using the primers C1-J-1718 (5'-GGAGGATTTGGAAATTGATTAGTTCC-3') and C1-N-2191 (5'-CCCGGTAAAATTAAAATATAAACTTC-3'; Simon et al. 1994), as described in Rugman-Jones et al. (2012). We also amplified two separate regions of nuclear ribosomal RNA, the D2 region of 28S (28S-D2) and the internal transcribed spacer 2 (ITS2), using primers and protocols described in Rugman-Jones et al. (2010) and Morse et al. (2016), respectively. All three loci have been widely used for investigating species boundaries among insects. Amplifications were confirmed by gel electrophoresis, purified using a PCR Product Pre-Sequencing Kit (Applied Biosystems, Waltham, MA, USA), and direct sequenced in both directions at the Institute for Integrative Genome Biology, University of California at Riverside. The parity of forward and reverse reads was checked using SEQUENCHER 4.9 (Gene Codes Corporation, Ann Arbor, Michigan, USA) and priming regions were removed manually in BioEdit version 7.0.5.3 (Hall 1999). The online tool, EMBOSS Transeq (Rice et al. 2000) was used to translate the protein coding COI sequence into its amino acid chain, confirming the absence of indels and pseudogenes. All sequences were deposited in GenBank (Benson et al. 2008).

Genetic analysis

Since our primary goal for the genetic analysis was obtaining molecular support of the likely conspecificity of the macropterous and strongly brachypterous individuals of both sexes of the reared *Cleruchus* species, direct comparison of the sequences was sufficient. Given a complete absence of any DNA sequence from positively identified species of *Cleruchus* in public repositories (i.e. GenBank and BOLD), further molecular identification was not possible.

Results

Taxonomy

Cleruchus breviclava Triapitsyn & Coray, sp. nov.

https://zoobank.org/D740697D-79BA-4EDB-AD6E-DE2A5171DA4A

Figs 1–5

Cleruchus sp.: Coray et al. 2022: 89–90 (host association, list of specimens reared in Basel, descriptive notes, illustrations).

Type material. ***Holotype*** female (macropterous individual), deposited in NHMB, on slide labeled: 1. "SWITZERLAND: Basel-Stadt Basel, Universitäre Psychiatrische Kliniken 47°34'16.75"N, 7°33'50.15"E, 266 m 27.vi.2021, P. Vlček. Associated with *Cis chinensis* Lawrence in *Antrodia xantha* fungus on *Pinus strobus* block, subsequent series 9.vii.2021, A. Coray"; 2. "Mounted by V. V. Berezovskiy 2021 in Canada balsam"; 3. [magenta] "*Cleruchus breviclava* Triapitsyn & Coray HOLOTYPE ♀"; 4. "Det. by S. V. Triapitsyn 2021"; 5. [barcode database label/unique identifier] "UCRC [bold] UCRC_ENT 00541415". The holotype (Figs 1, 2a–c) has a pair of wings detached and mounted under the same coverslip.

Paratypes. 7 females and 3 males on slides [including 2 females (1 macropterous and 1 strongly brachypterous) and 2 males (1 macropterous and 1 strongly brachypterous), UCRC (molecular vouchers PR21-581–584, UCRC_ENT 00541371–00541374)], same data as holotype. All other specimens listed in Coray et al. (2022) from the type locality (as *Cleruchus* sp.) and deposited in NHMB are also included in the paratype series.

Additional specimens from Germany and Switzerland (other than from the same rearing at the type locality in Basel), listed by Coray et al. (2022), are not included in the type series; these are mostly stored in ethanol in NHMB.

Diagnosis. Morphologically, fully winged female individuals of *C. breviclava* are most similar to those of the Palaearctic species *C. detritus* Bakkendorf, the type series of which was collected from soil in Chancy, Geneva, Switzerland (Bakkendorf 1964). Its lectotype female (Fig. 6) was designated by Triapitsyn et al. (2013) from one of the two macropterous original syntypes. In macropterous *C. breviclava*, the female antennal clava (Fig. 2a) is consistently relatively shorter than that in fully winged *C. detritus* (Fig. 6), in which it is approximately the same length as combined length of F3–F6 according to the redescription in Triapitsyn (2014), being slightly shorter than the combined length of F4–F6 (but about as long as F4–F6 in the smaller, brachypterous female of *C. breviclava*). The body of *C. breviclava* is notably longer (0.6–0.76 mm in macropterous, slide-mounted females) than that of macropterous females of *C. detritus* (0.45 mm according to Bakkendorf 1964), and the gaster is markedly longer (compare Figs 1a, 2c and Fig. 6b, respectively), which is common in fungus dwelling species of the genus. Combined with notably shorter setae on the fore wing venation in *C. breviclava* (Fig. 1b), and a different habitat (fungus versus soil for *C. detritus*), this strongly supports that these two species are clearly distinct despite having some morphological similarities in proportions of female funicular segments and fore wing chaetotaxy.

A key to both sexes of the European species of *Cleruchus*, which is based on that of the Palaearctic species in Triapitsyn (2014), is provided below to further facilitate their recognition.

Description. Female (holotype). Body (Fig. 1a) brown to dark brown (gaster a little lighter, often basally only); scape and pedicel light brown, flagellum brown; legs mostly light brown. Head (Fig. 2b) a little wider than long in dorsal view, and about as wide as mesosoma. Vertex smooth; ocelli present but somewhat reduced, oval. Face subquadrate, small, faintly sculptured, with one seta near inner lower side of each torulus; torulus large, subtriangular, slightly below lower level of eyes, touching preorbital trabecula. Mandible bidentate. Antenna (Fig. 2a) with scape smooth, 4.5× as long as wide (including small radicle); pedicel smooth, 1.7× as long as wide, much longer than F1; F1 about as long as wide, much shorter than following funiculars; F2–F5 longer than wide, F2 shorter than following funiculars, F4 and F5 the longest and F6 the widest funiculars; F4–F6 each with 1 mps; clava a little shorter than F4–F6 combined, entire, 2.6× on one antenna and 2.7× on the other antenna as long as wide, with 6 mps. Mesosoma (Fig. 2b) mostly smooth except axilla with a faint sculpture. Mesoscutum wider than long, its midlobe with a pair of adnotaular setae. Axilla with 1 weak seta. Scutellum a little shorter than mesoscutum. Metanotum narrow, strap-like and hardly noticeable, with 2 very weak setae. Propodeum long, longer than mesoscutum or scutellum. Mesophragma broadly U-shaped, almost extending to posterior margin of propodeum. Macropterous (Fig. 1a–c). Fore wing (Fig. 1b) 10.4× as long as wide, with venation typical of the genus; both macrochaetae very short; blade infuscate throughout, with 2 rows of microtrichia along anterior margin and 1 almost complete row of microtrichia along posterior margin; longest marginal seta 4.4× greatest width of wing. Hind wing (Fig. 1c) 21× as long as wide; blade slightly infuscate, with one incomplete row of microtrichia closer to anterior margin; longest marginal seta 6.2× greatest

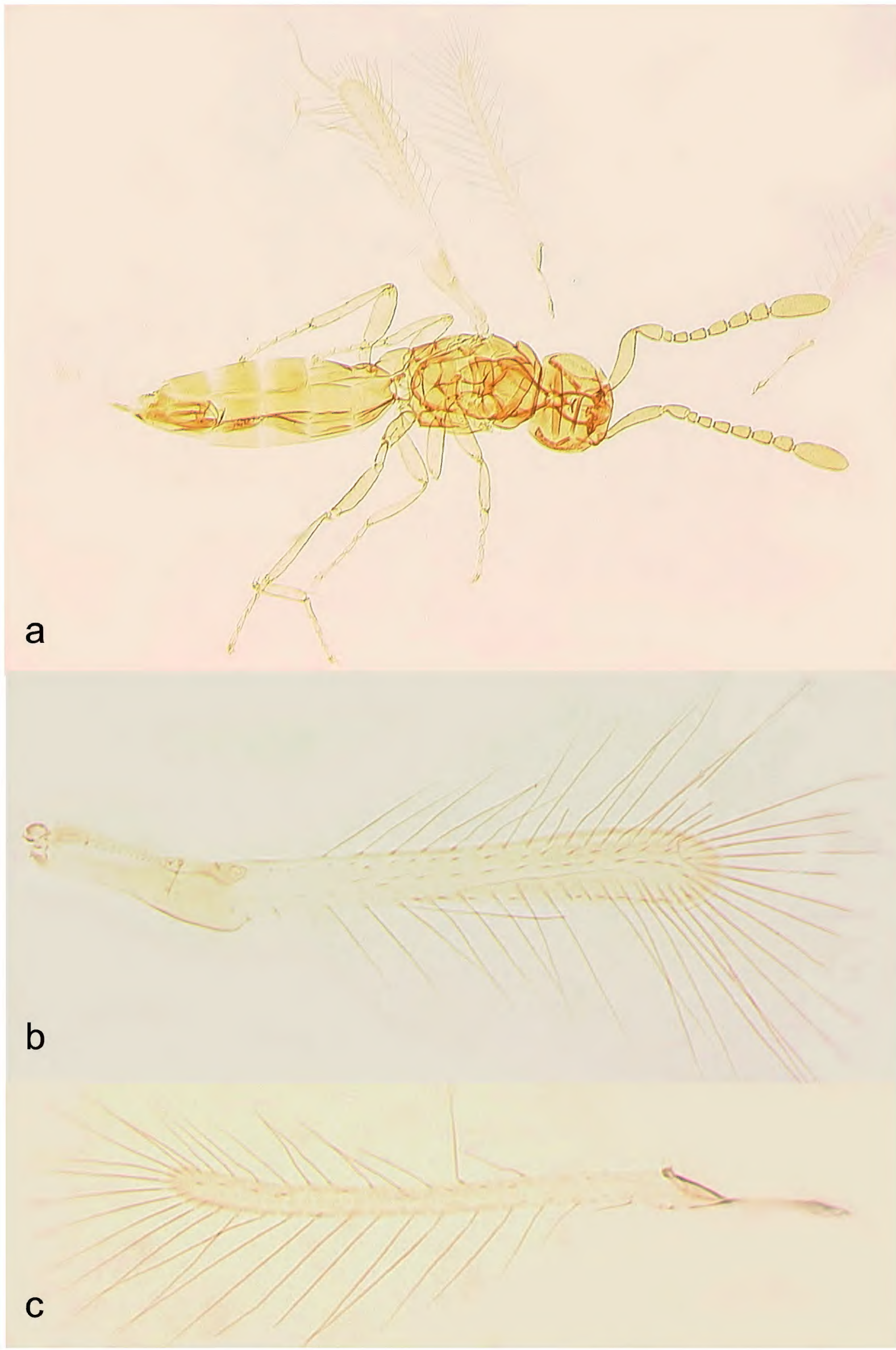

Figure 1. *Cleruchus breviclava* sp. nov., holotype female. **a.** Habitus (slide-mounted); **b.** Fore wing; **c.** Hind wing.

width of wing. Petiole (Fig. 2b, c) short but clearly visible in slide-mounted specimens, 2.0× as wide as long. Gaster (Fig. 2c) elongate, twice as long as mesosoma in the slide-mounted specimen; ovipositor 1.25× length of metatibia and about 0.4× 1ength of gaster, exserted beyond its apex.

Measurements (μm) of the holotype (as length or length: width). Body: 665; mesosoma 185; petiole 19; gaster 370; ovipositor 152. Antenna: scape (including radicle) 97; pedicel 36; F1 12; F2 18; F3 23; F4 27; F5 27; F6 25; clava 82. Fore wing 376: 36; longest marginal seta 157. Hind wing 378: 18; longest marginal seta 112.

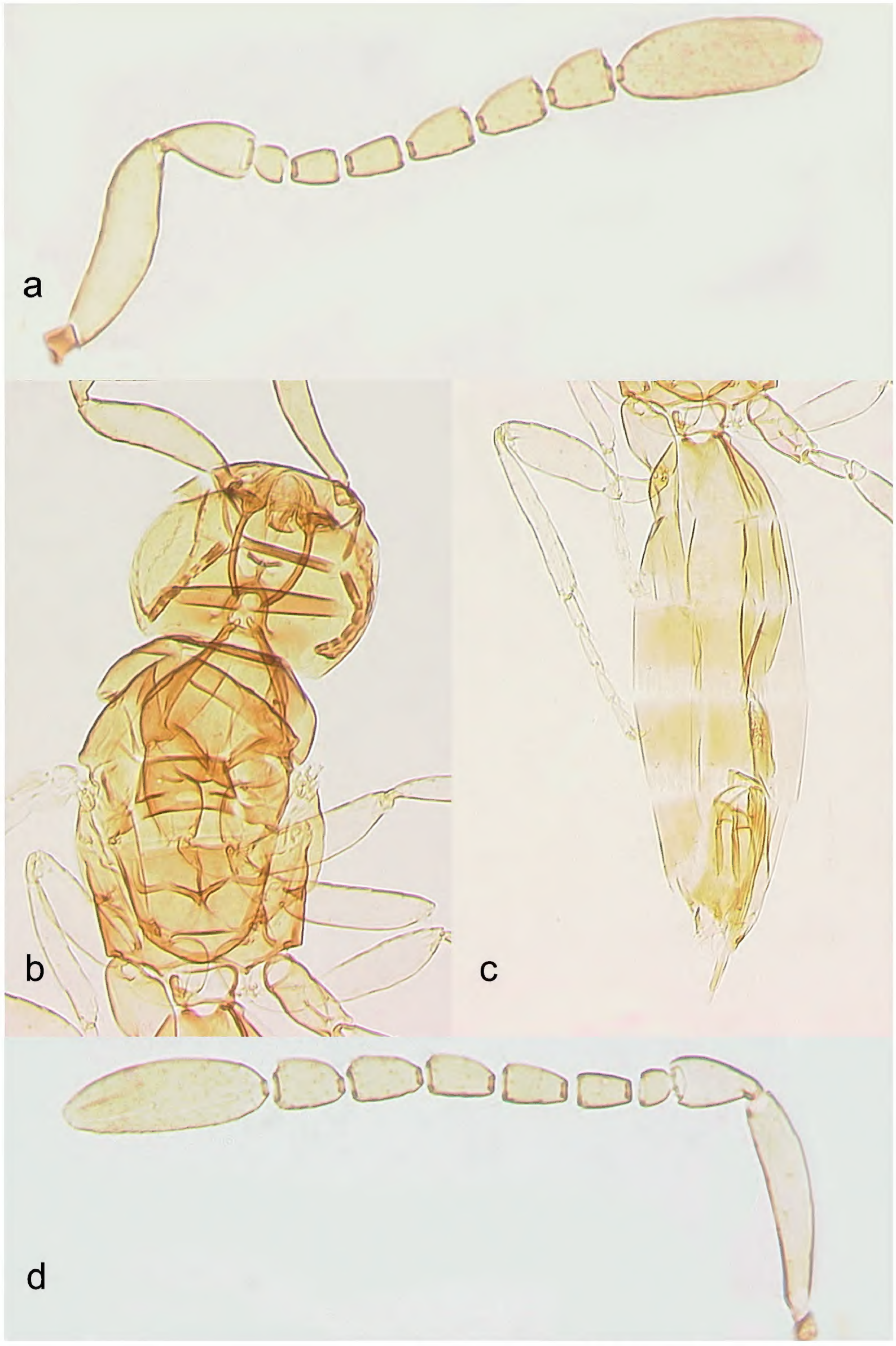

Figure 2. *Cleruchus breviclava* sp. nov., female. **a.** Antenna (holotype; mps on F4–F6); **b.** Head, mesosoma and petiole (holotype); **c.** Metasoma (holotype); **d.** Antenna (macropterous paratype; mps on F3–F6).

Variation. Macropterous paratypes: body length of slide-mounted specimens 600–760 µm; mps usually on F4–F6 (1 on each) but sometimes F3 with 1 mps (Fig. 2d) on one or both antennae, clava 2.6–2.8× as long as wide; fore wing 8.6–9.5× as long as wide; ovipositor 1.2–1.3× length of metatibia. Strongly brachypterous paratype (Fig. 3a, b): body length of slide-mounted specimen (Fig. 3b) 515 µm; ocelli present but relatively more reduced than in macropterous individuals; antenna (Fig. 3c) relatively shorter than in macropterous individuals,

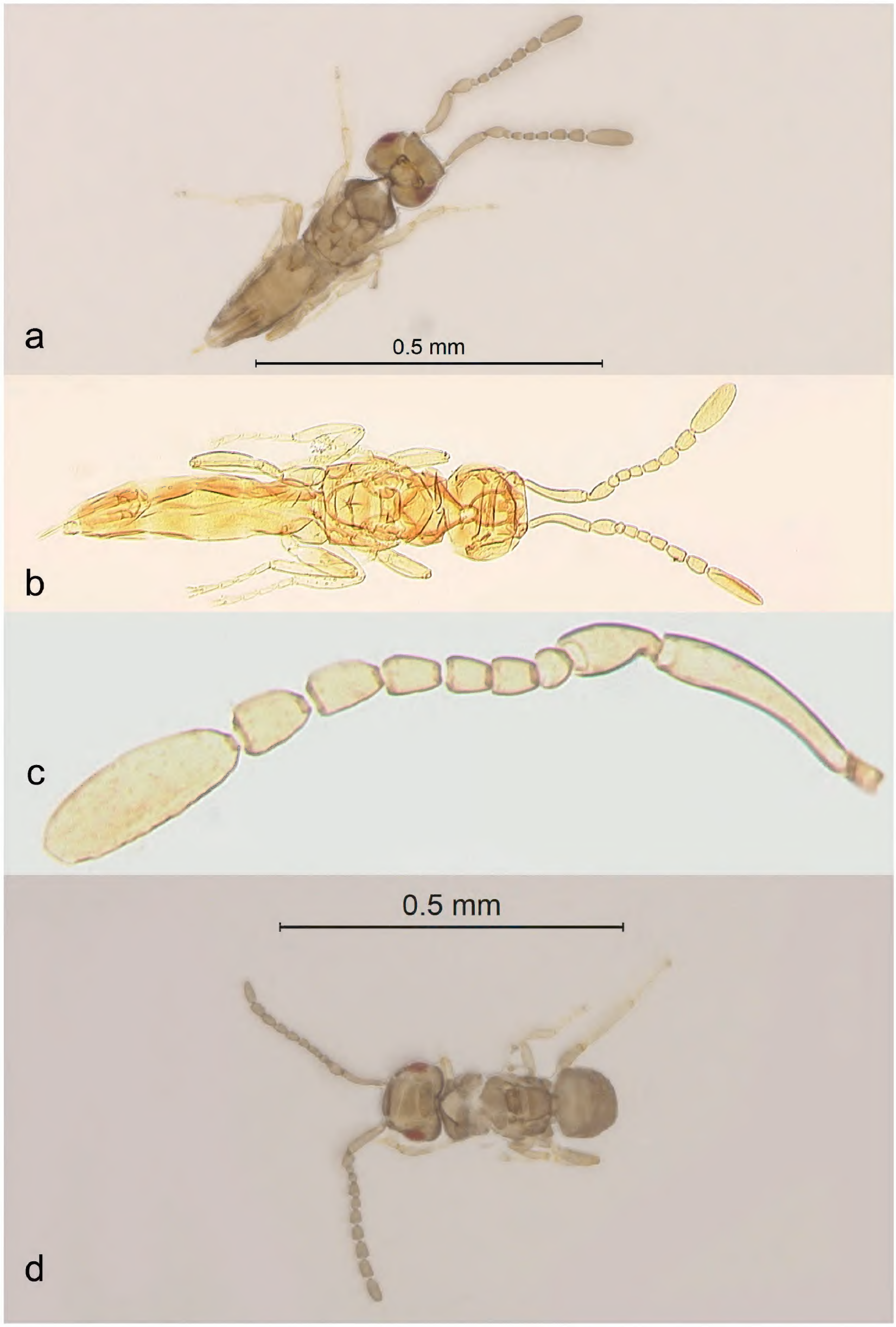

Figure 3. *Cleruchus breviclava* sp. nov. (strongly brachypterous paratypes). **a.** Habitus of female (in ethanol); **b.** Habitus of the same female (slide-mounted); **c.** Female antenna (mps on F5–F6); **d.** Habitus of male (in ethanol).

particularly F2–F4, mps only on F5 and F6 (1 on each), clava as long as F4–F6 combined; fore wing reduced to small, very short stub with a few short setae; hind wing apparently absent; ovipositor length 120 µm, 1.3× length of metatibia.

Male. Macropterous paratypes (Fig. 4c): body length of slide-mounted specimens 585–590 µm. Ocelli (Fig. 5c) as in macropterous females. Antenna (Fig. 5a) with flagellum 10-segmented; scape (including radicle) 5.3× as long as wide; F1 shorter than following flagellomeres and with-

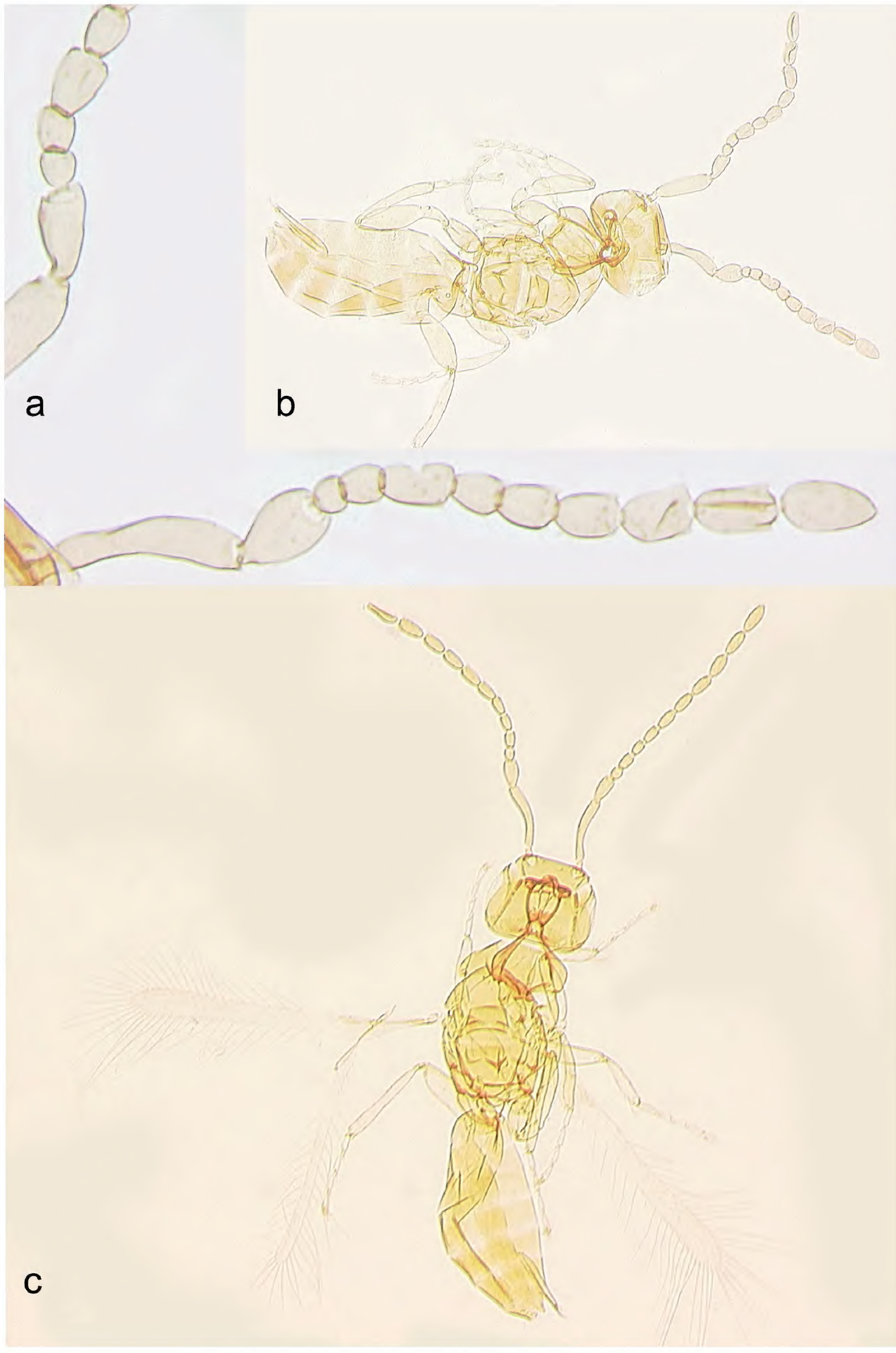

Figure 4. *Cleruchus breviclava* sp. nov., male (paratypes). **a.** Antennae (strongly brachypterous individual; F3 and F4 partially fused on one antenna and completely fused on the other antenna); **b.** Habitus of strongly brachypterous individual (slide-mounted, same specimen as on Fig. 3d); **c.** Habitus of macropterous individual (slide-mounted).

out mps; F2–F10 each with at least 1 mps, F10 the longest flagellomere. Fore wing (Fig. 5b) 9.8–10.4× as long as wide. Gaster 1.3–1.4× as long as mesosoma; genitalia (Fig. 5d) length 106 µm. Strongly brachypterous paratype (Figs 3d, 4b): body length of slide-mounted specimen 470 µm. Ocelli apparently absent. Antenna (Fig. 4a) notably short-

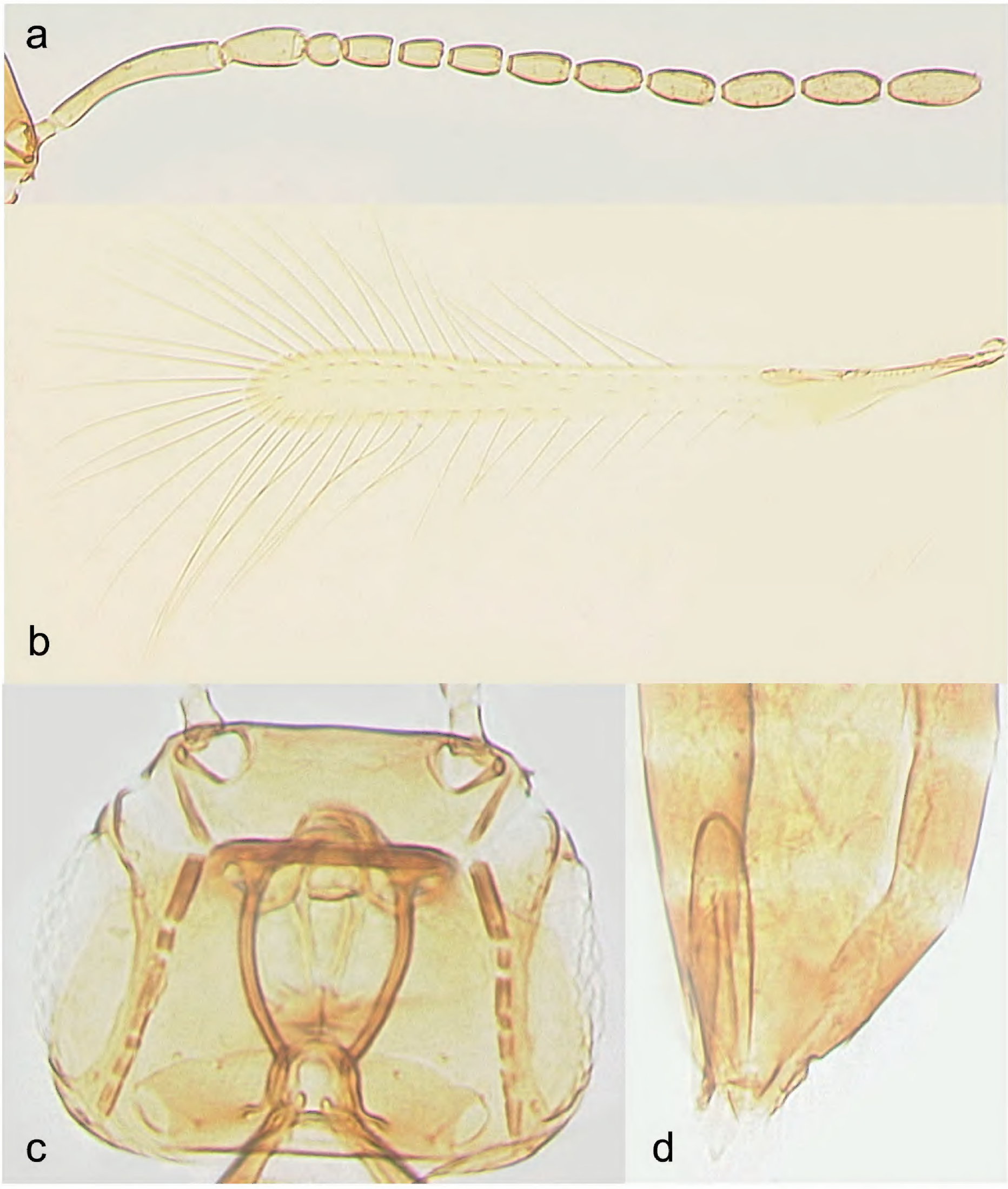

Figure 5. *Cleruchus breviclava* sp. nov., male (macropterous paratypes). **a.** Antenna; **b.** Fore wing; **c.** Head in dorsal view; **d.** Genitalia in dorsal view.

er than in macropterous individuals (some flagellomeres relatively shorter), with flagellum 9-segmented (F3 and F4 completely fused on one antenna but only partially fused on the other), scape (including radicle) 4.2× as long as wide, F1 and F2 without mps. Genitalia length 94 µm.

Etymology. The new species name is a noun in apposition referring to a relatively short antennal clava, compared to that in otherwise more or less similar congeners such as *C. detritus*.

Distribution. Palaearctic region: Switzerland, and Germany (Coray et al. 2022 [as *Cleruchus* sp.]).

Host. Coleoptera, Ciidae: *Cis chinensis* Lawrence, 1991 in *Antrodia xantha* fungus (Polyporales, Fomitopsidaceae) on a block of *Pinus strobus* (Pinaceae).

Molecular analysis. Four specimens of *C. breviclava* were extracted but only three yielded amplifiable DNA: PR21-581, PR21-582, and PR21-584. The DNA sequences of the COI (502 bp) and 28S-D2 (519

bp) regions were identical across all three specimens (GenBank accessions: OP758808–OP758810 and OP755253–OP755255, respectively). The ITS2 region (432 bp) of the two male specimens was also sequenced and found to differ at only a single nucleotide position (A-T at position 222; OP755251–OP755252). Taken together, the almost identical nature of these three loci provided unambiguous evidence that at least the three individual wasps of *C. breviclava* from which we were able to amplify and sequence DNA (one macropterous female, one macropterous male, and one strongly brachypterous male) are clearly conspecific. Although the DNA extraction from the fourth specimen (a strongly brachypterous female) appears to have failed, we believe it represents the same species. That is corroborated by the fact that all the wasps emerged from the same fungus.

Key to both sexes of the described species of *Cleruchus* in Europe

1 Female (antenna with flagellum 7-segmented, consisting of a 6-segmented funicle and an entire clava) 2
– Male (antenna with flagellum filiform, 9-, 10-, or 11-segmented)..... 19
2 Apterous or strongly brachypterous (all wing stubs, if present, with membrane strongly reduced, at most extending a little beyond apex of venation)..... 3
– Macropterous or slightly to moderately brachypterous (fore wing disc, even if somewhat reduced, extending far beyond apex of venation) 8
3 Most funiculars either a little wider than long or at most as long as wide (a few may be a little longer than wide) .... *C. szelenyi* Novicky
(also apterous paralectotypes of *C. detritus* Bakkendorf that may or may be not conspecific with *C. szelenyi*)
– Most funicle segments clearly longer than wide (a few may be about as long as wide) 4
4 F2–F6 each with 1 mps 5
– At most F5 and F6 each with 1 mps..... 6
5 Body length (of dry-mounted specimens) at least 0.5 mm; body relatively more elongate; funiculars relatively longer and clava at least 3.7× as long as wide ..... *C. polypori* Triapitsyn & Moraal (part)
– Body length (of dry-mounted specimens) at most 0.46 mm; body relatively less elongate; funiculars relatively shorter and clava at most 2.9× as long as wide ..... *C. kivach* Triapitsyn (part)
6 Ovipositor at most 0.65× length of metatibia ..... *C. janetscheki* Novicky (part)
– Ovipositor at least 1.3× length of metatibia..... 7
7 F1 notably longer than wide; F5 apparently without mps and longer than F6 ..... *C. terebrator* Viggiani
– F1 about as long as wide; F5 with 1 mps and about as long as F6 ..... *C. breviclava* Triapitsyn & Coray, sp. nov. (part)
8 Ocelli absent 9
– Ocelli present..... 11
9 F2 and F3 each with 1 mps; fore wing normal (not reduced, with many marginal setae) 10
– F2 and F3 without mps; fore wing very narrow, with disc reduced (but extending far beyond apex of venation), and with a few discal and most marginal setae short except for 2 or 4 very long marginal setae at wing apex .... *C. biciliatus* (Ferrière)
10 Body length (of dry-mounted specimens) at least 0.5 mm; body relatively more elongate; funicle segments relatively longer and clava at least 3.7× as long as wide ..... *C. polypori* Triapitsyn & Moraal (part)
– Body length (of dry-mounted specimens) at most 0.46 mm; body relatively less elongate; funicle segments relatively shorter and clava at most 2.9× as long as wide ..... *C. kivach* Triapitsyn (part)
11 Admarginal row of discal setae along posterior margin of fore wing absent or incomplete (at most composed of a few setae behind and just beyond stigmal vein and also at wing apex)..... 12
– Admarginal row of discal setae along posterior margin of fore wing present and complete or almost complete (Fig. 1b)... 13
12 Fore wing with discal setae of the median row relatively long ..... *C. megatrichus* Novicky
– Fore wing with discal setae of the median row relatively short..... *C. leptosoma* Debauche
13 F3 with 1 mps at least on one antenna 14
– F3 without mps 16
14 F1 either wider than long or about as long as wide (Fig. 2a, d) 15
– F1 longer than wide..... *C. nikaknet* Triapitsyn
15 Clava either a little shorter or subequal, or slightly longer than combined length of F3–F6 (Fig. 6a) .... *C. detritus* Bakkendorf
– Clava slightly shorter than combined length of F4–F6 (Fig. 2a, d) ..... *C. breviclava* Triapitsyn & Coray, sp. nov. (part)
16 F4 with 1 mps..... *C. breviclava* Triapitsyn & Coray, sp. nov. (part)
– F4 without mps 17
17 Clava notably lighter than funicle; F1 clearly longer than wide..... *C. janetscheki* Novicky (part)
– Clava concolorous with funicle; F1 either about as long as wide or at most slightly longer than wide..... 18
18 Collected in northern Europe during summer [male antenna 12-segmented]..... *C. pluteus* Enock
– Collected in northern Europe during spring [male antenna 13-segmented]..... *C. taktochno* Triapitsyn

19 Apterous or strongly brachypterous (all wing stubs, if present, with membrane strongly reduced, at most extending a little beyond apex of venation) 20
– Macropterous or slightly to moderately brachypterous (fore wing disc, even if somewhat reduced, extending far beyond apex of venation) 25
20 Ocelli present 21
– Ocelli absent 22
21 Antenna with flagellum 9-segmented and F1–F6 wider than long ..... *C. raignieri* Debauche
– Antenna with flagellum 10-segmented and F1–F6 at least a little longer than wide ..... *C. janetscheki* Novicky
22 Antenna with flagellum 9-segmented or appearing 9-segmented (when 10-segmented in macropterous individuals but in strongly brachypterous, smaller individuals with F3 and F4 completely or partially fused, Fig. 4a) 23
– Antenna with flagellum 11-segmented 24
23 F2 wider than long ..... *C. szelenyi* Novicky
– F2 slightly longer than wide; F3 and F4 completely or partially fused (Fig. 4a) ..... *C. breviclava* Triapitsyn & Coray, sp. nov. (part)
24 F1 relatively smaller and subglobular (about as long as wide) ..... *C. polypori* Triapitsyn & Moraal
– F1 relatively larger and a little longer than wide ..... *C. kivach* Triapitsyn
25 Antenna with flagellum 10-segmented 26
– Antenna with flagellum 11-segmented 27
26 F1 with 1 mps; admarginal row of discal setae along posterior margin of fore wing complete ..... *C. pluteus* Enock
– F1 without mps (Fig. 5a); admarginal row of discal setae along posterior margin of fore wing not complete (Fig. 5b) ..... *C. breviclava* Triapitsyn & Coray, sp. nov. (part)
27 Fore wing with discal setae of the median row relatively long ..... *C. megatrichus* Novicky
– Fore wing with discal setae of the median row relatively short ..... *C. taktochno* Triapitsyn

New records of some other species of *Cleruchus* in Europe

Cleruchus megatrichus Novicky, 1965

Cleruchus megatrichus Novicky, 1965: 59–60 (in key). Type locality (of the lectotype designated by Triapitsyn et al. 2013: 10): forest at Mienia, Mińsk Mazowiecki, Mińsk County, Masovian Voivodeship, Poland.

Cleruchus megatrichus Novicky: Triapitsyn et al. 2013: 10–12 (information on type series, redescription, illustrations, distribution); Triapitsyn 2014: 7–8 (key), 20–22 (taxonomic history, distribution, diagnosis, illustrations).

Material examined. Spain, Valencia, Valencia, 25.vi.2021, citrus orchard [1 macropterous female, MCAN].

Distribution. Finland, France (Triapitsyn et al. 2020), Poland (Novicky 1965), Spain (Triapitsyn 2014).

Hosts. Unknown.

Cleruchus szelenyi Novicky, 1965

Cleruchus szelényi [sic] Novicky, 1965: 58, 60 (in key). Type locality (of the lectotype designated by Triapitsyn et al. 2013: 12): Svábhegy [hill], Budapest, Hungary (according to the original description but on the labels on the syntypes probably the correct locality is indicated – Köhegy, Pomáz, Pest County, Hungary (Triapitsyn et al. 2013)).

Cleruchus szelenyi Novicky (specimens from Hungary only): Triapitsyn et al. 2013: 12–14 (information on type series, redescription, illustrations, distribution); Triapitsyn 2014: 6, 8 (key), 40 (taxonomic history, diagnosis, distribution).

Material examined. Germany, Rheinland-Pfalz, Winden, 7.vi.2013, pitfall trap in apple orchard [1 apterous female, MCAN]. Netherlands, Gelderland, Renkum, Sinderhoeve, 30.vi.2010, pitfall trap in grassland [3 apterous females, MCAN (2), UCRC (1)].

Distribution. Hungary (Novicky 1965), Germany (new record), Netherlands (new record).

Hosts. Unknown. The original syntypes were collected by sifting from lawn soil (Novicky 1965; Triapitsyn et al. 2013).

Cleruchus taktochno Triapitsyn, 2014

Cleruchus taktochno Triapitsyn, 2014: 41–47. Type locality: Heverlee, Leuven, Flemish Brabant, Belgium.

Material examined. Netherlands, Gelderland, Renkum, Sinderhoeve, 30.vi.2010, pitfall trap in grassland [1 macropterous male, MCAN].

Distribution. Belgium, Denmark (Triapitsyn 2014), Finland (Triapitsyn et al. 2020), Netherlands (new record), Poland (Triapitsyn 2014).

Hosts. Unknown.

Discussion

Although the minute tree-fungus beetle *Cis chinensis* is invasive in Switzerland (Coray et al. 2022), its egg parasitoid *C. breviclava* is most likely native to the country, as *Cleruchus* species are unlikely to be monophagous and most probably can easily switch to parasitize eggs of congener hosts in similar habitats, in this case from other *Cis* spp. native to Europe. Indeed, *C. breviclava* was also reported, as *Cleruchus* sp. (Coray et al. 2022), from

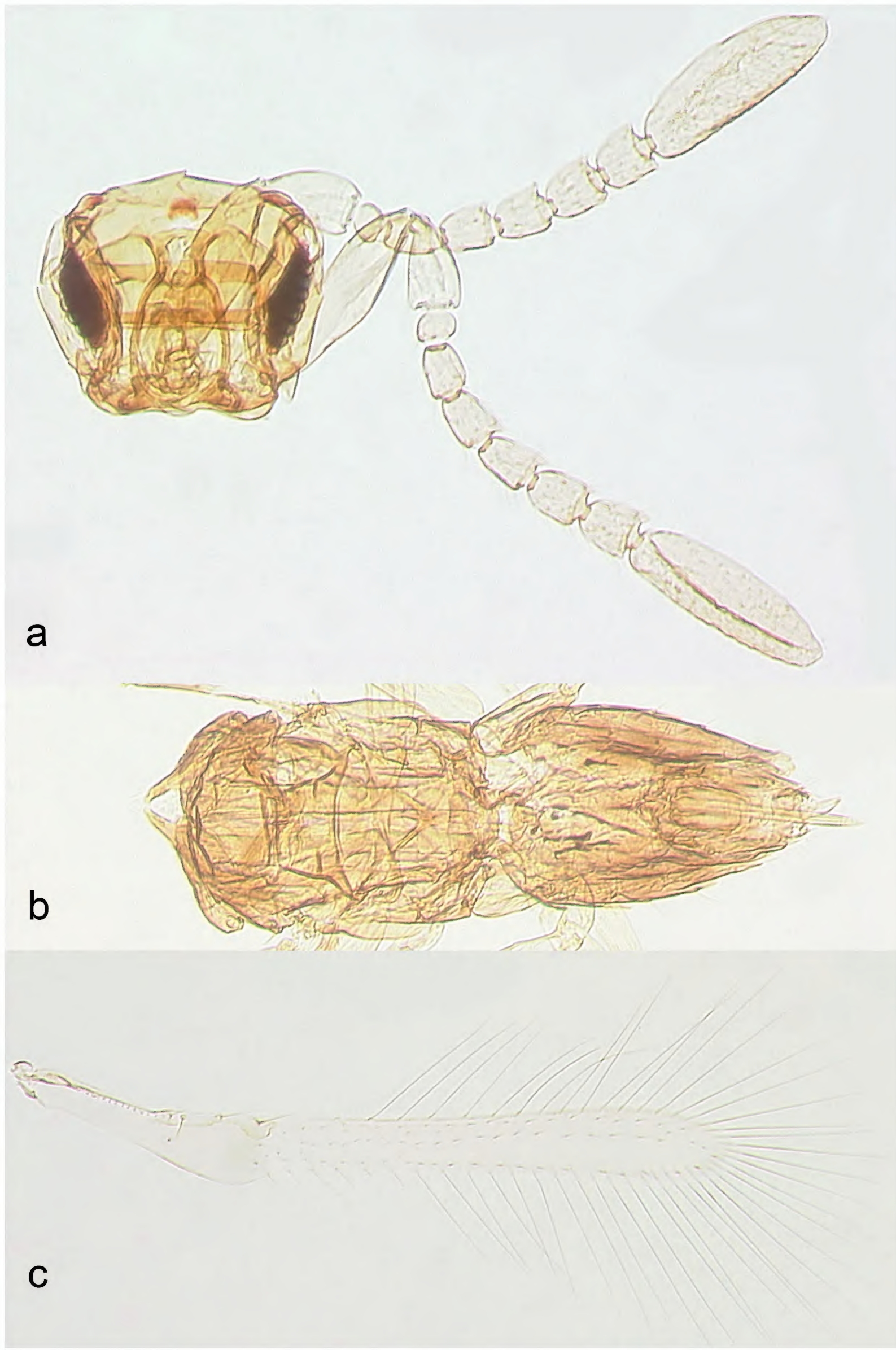

Figure 6. *Cleruchus detritus* Bakkendorf, female (lectotype): **a.** Head and antennae; **b.** Mesosoma and metasoma; **c.** Fore wing.

low mountains in Germany (Baden-Württemberg) and Switzerland (Basel-Landschaft Canton) from *Stereum* spp. (Russulales: Stereaceae) fungi infested with native *Cis* spp. That is also supported by the fact that our COI sequences of *C. breviclava* from Basel are 97.6% similar to that of an unidentified female of *Cleruchus* sp., only partially released in BOLDSYSTEMS (BOLD Record BCHYM5773-15, accessed 15.iv.2022), which is also very similar morphologically according to its digital image, from the nearby Grenzach-Wyhlen, Baden-Württemberg, Germany (47.5547°N, 7.6658°E, 357 m, collected 27.viii.2011 by D. Doczkal and A. Ssymank, deposited in Zoologische Staatssammlung München, Bavaria, Germany [SNSB], BC-ZSM-HYM-22592-G01).

Diversity of *Cleruchus* species in Europe is still poorly known, due to their often concealed habitats requiring laborious sampling of various ecological microniches. Because of significant intraspecific variability and frequent occurrence of brachypterous and apterous individuals of the same species with conspecific macropterous individuals, and associated reductions and fusions of flagellar segments in males, possible reduction or lacking of ocelli in smaller individuals with reduced or absent wings, and apparent size-dependent reduction of the number of mps on female funicular segments of the antenna, which are all commonly used diagnostic features for *Cleruchus* species recognition (Triapitsyn 2014), use of molecular methods and building of genetic libraries are of primary importance for taxonomy of the genus. That task, however, is unfortunately not feasible to be achieved for all the already described species of the genus either in the near or even a more distant future, due to the aforementioned difficulties in their collection and recognition.

This is the first attempt to apply an integrative taxonomy approach to this genus, albeit to a single species, while genetic data for other positively identified congeners are currently lacking. Thus, the true number of valid *Cleruchus* species in Europe is likely to increase in the future (for instance, see information on the four undescribed species in Triapitsyn 2014), although some nominal species, particularly those described based on strongly brachypterous or apterous individuals, may turn out to be synonymous with other species with only macropterous individuals known so far.

Genetically confirmed conspecificity of the morphologically quite different macropterous female and both macropterous and strongly brachypterous males of *C. breviclava*, which are also quite variable in body size, casts doubt on correctness of the treatment of the type series of *C. detritus* as being two different species, the macropterous females as true *C. detritus* (based on the lectotype designation by Triapitsyn et al. 2013) and the apterous females as *C. szelenyi* (Triapitsyn et al. 2013; Triapitsyn 2014). The latter were treated as an "apterous form" by Bakkendorf (1964) and "forma *aptera*" by Novicky (1965). The original syntypes of *C. detritus* consisted of 11 apterous and 2 macropterous females collected by washing from soil ("lavage de terre") (Bakkendorf 1964) which may or may not be conspecific, as this collecting method could easily yield two different species in the same location. However, the other scenario, in which the apterous, slightly smaller females of *C. detritus* (with ocelli absent) could be conspecific with somewhat larger, macropterous ones (with ocelli apparently present) is also possible in spite of the two types of females being morphologically quite different also in the following: female antenna of the apterous syntypes usually lacks mps on all funicular segments (except sometimes 1 mps apparently may be present on F6) whereas these are present on F3–F6 of the macropterous syntypes (Triapitsyn et al. 2013; Triapitsyn 2014). Thus, genetic studies on freshly collected specimens, both macropterous and apterous, from the type locality of *C. detritus* are needed to reveal the true identity of this nominal species. Resulting sequences will also need to be compared with those of *C. breviclava* (particularly with brachypterous individuals) and *C. szelenyi*, at least, although for the latter they are not yet available either.

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